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INFORMATION SHEET ON PACKAGING AND STORAGE OF DEHYDRATED VEGETABLES

Bureau of Agricultural Chemistry and Engineering
Agricultural Research Administration
U. S. Department of Agriculture

Packages for dehydrated vegetables must protect the quality of the contents under severe conditions of export shipment and storage. These conditions vary within a wide range, and for that reason tin-plate cans, hermetically sealed for certain dehydrated vegetables or with friction tops for others, are widely used and preferred. Other containers are included in the tentative specifications for both the U. S. Army and the Lend-Lease purchases 1/ but have not been used to any great extent. Through the issuance on July 21, 1942, of Bulletin SPQSD 457 (Chicago) the Quartermaster General has approved the use of a sealed, foil package. Use of this package has been requested as materials for it become available and when the present stocks of cans are exhausted.

Another information sheet in preparation is for manufacturers of protective wrappings, packages, and package machinery. Those who want further information on substitutes for tin plate should write for that sheet.

The Packing Room

Experienced food processors realize that the packing room must be maintained in the best of sanitary conditions. It should be well lighted, well ventilated, and screened. The floor should be smooth and free of cracks. It should be easily cleaned and easily kept free of debris. A concrete floor with a slight slope and drains for ready flushing is best. Permit no accumulation of dried vegetable refuse to remain from shift to shift. Insects breed readily under dark, moist conditions.

Containers Required

The number of containers required daily in a dehydration plant usually is not large. Not many dehydration plants exceed 50 tons in daily input. The net output is about one-tenth of the original weight. While 2-gallon cans are listed in specifications, the 5-gallon size is most common. Table 1 shows the dehydration ratios and range of net weights per 5 gallons commonly used commercially, and the number of 5-gallon cans required per day for every 10 tons of input from the field. A 25-percent [illegible] has been assumed.

1/ For U. S. Army specifications write the Commanding General, Chicago Quartermaster Depot, 1819 West Pershing Road, Chicago, Illinois, and for Federal specifications apply to the Agricultural Marketing Administration, U. S. Department of Agriculture, Washington, D. C.

Table 1

[illegible] For Estimating Container Demand

Vegetable	[illegible]	Weight per 5 gallons Lbs.	Drying Ratio, Raw Prepared to Dry Lbs.	No. of 5-gal. Cans per 10 Tons Raw, Untrimmed Vegetable
Beets	[illegible]	10	8 - 9 to 1	[illegible] - 190
Cabbage	Shredded	5	10 - 15 to 1	200 - 300
Carrots	[illegible]	14	3 - 11 to 1	100 - 130
Onions	[illegible]	9 - 12	9 - 11 to 1	[illegible] - 190
Potatoes, white	[illegible]	16	4 - to 1	[illegible] - 230
Potatoes, white	[illegible]	10 - 15	4 - 5 to 1	[illegible] - 360
Sweetpotatoes	[illegible]	12	3 - 4 to 1	[illegible] - 420

No standard [illegible] can have been established. Table 1 shows that the greatest demand [illegible] on the basis of raw input to the plant will come from sweetpotatoes. [illegible] plant would require 1500 to 2000 5-gallon cans per 24 hours. While [illegible] a considerable volume it requires the handling of only 60 to 80 [illegible]. Because of this low requirement, highly mechanized packaging [illegible] not used in plants where 5-gallon cans are the containers for [illegible] vegetables.

[illegible]ing-Room Equipment

The scale sho[illegible]-pound range at most, since the gross will be generally not over [illegible] pounds. An attachment for indicating the amount over or under is [illegible] tare weight should be provided.

A sorting table or conveyor is frequently required. This may be used for various purposes, [illegible] removal of off-color pieces, and separation of lumps of insufficiently [illegible].

A large, flat [illegible] funnel is frequently used when tray loads of product are dumped into [illegible]. It is preferable to pack directly into shipping containers so far as [illegible]practicable, thus avoiding chance insect infestation. In some cases, [illegible] pre-equalizing bins provided with chutes which open over the filling [illegible] used.

Vibrators are [illegible] used in packing to produce a higher bulk density. Cabbage is pressed [illegible] fitted into the round openings of the cans.

Cans may be [illegible] friction [illegible], soldered tops with [illegible] holes, or tops which can be [illegible] machine. Hand or rotating flame [illegible] equipment will be needed for the first two types. Semi-automatic cap [illegible] or seamers will be required when solder is not used. [illegible] from can manufacturers. [illegible] irons with more than normal [illegible] will probably [illegible] melting point [illegible].

The bag-in-box container described in Bulletin [illegible] will require a [illegible]-sealing machine with thermostatically controlled, [illegible] jaws, controlled pressure and crimp type [illegible] usual.

Sealing the Cans

The tentative [illegible] call for a hermetic seal for [illegible] and carrots. One definition of a hermetic seal is that it will contain [illegible] or vapors without leakage for long periods. The absence of leakage is shown by the maintenance of [illegible] pressure in cans which are [illegible]. The term [illegible] may have different [illegible] whether there is [illegible] vacuum, or an absence of [illegible].

Operators of [illegible] should bear in mind when packing [illegible] Army, Navy or [illegible] shipment that the product [illegible] mountains. One pass is [illegible] feet; others are 7000 feet, and there is considerable country at 5000 feet [illegible] to the east of the Rockies. [illegible] can is sealed at [illegible]. Subjection of such a sealed can filled at sea level to an [illegible] is equivalent to packing the can at 2 1/2 pounds per square inch (gauge) internal pressure. The [illegible] and closures must be tight at this pressure. If leaks occur, [illegible] pressure, part of the contained gas will escape and on approaching sea level [illegible] will be replaced with air. If [illegible] can were packed at sea level, [illegible] over a [illegible]-foot pass and returned to sea level, there would result [illegible] percent increase in the oxygen content of the can.

Packing in Air

The packing of dehydrated potatoes is typical of methods for all products which may be packed in air. The product must be protected from moisture absorption at temperatures occasionally as high as 130° F., or as low as -15° F. Insects must be excluded. [illegible] friction-top cans are used for potatoes. The cover is spot-soldered after the can is filled to hold it in place during rough handling.

Many strip-cutting machines produce strips the length of the potato. Some machines reduce the length to 3/4 inch. If the machine is of the former type, the dried strips may be broken to approximately 3/4 inch before packing. Various means for crushing may be utilized. Fines should be screened out. Of course the goal of the operator is to provide a product that may be restored to appearance as well as the [illegible] fresh vegetable. Vibratory methods should be considered, because vibration [illegible] not reduce the strip length, while crushing

does. Generally speaking, any dimension of a strip or slice over 1 inch is likely to result in loose packing. Some slices such as those of sweetpotatoes and white potatoes are exceptions. They yield noncurling slices and a relatively high weight per gallon of dehydrated product.

Dehydrated vegetables packed in air may be enclosed in nonrigid containers made with a laminated foil as the chief moisture-proof material. The vegetables included are both white potatoes and sweetpotatoes, turnips, and beets. The following description is abstracted from a detailed bulletin, mentioned earlier, issued by the Quartermaster General's office. The package is made up of an inner bag of laminated glassine. A second bag of heat-sealing cellophane, laminated to metal foil and kraft paper is outside of the first bag and packed in a 5-gallon carton. Two such cartons are packed in an outer box or carton. All producers of the dehydrated vegetables mentioned should obtain information regarding this package if they prepare Army shipments: (1) because it is stressed as a substitute for metal cans; and (2) because it is typical in construction of various types of carton liners of high moisture resistance. The individual cartons are lined and assembled by the use of a rectangular mandrel or frame.

Packaging in Carbon Dioxide or in Nitrogen

Absence of air is specified for cabbage and carrots. The purpose is to lengthen storage life, since in the presence of air the palatability, vitamin content, and color are lost more rapidly than in its absence. The containers which may be used are solder-top, rectangular cans or cans provided with a machine-sealing, non-soldered top.

It is recommended that for specification purposes a definite maximum limit of 2 percent be set on the oxygen content of sealed containers. The analysis is to be made at least 12 hours after filling and sealing.

There are three methods by which air may be displaced effectively below the 2 percent oxygen limit. They are: (1) the carbon dioxide snow or "dry ice" method; (2) the vacuum bell method; and (3) the cylinder and meter method.

Carbon Dioxide "Snow" Equipment

The carbon dioxide "snow" method is recommended as suitable when shipment and storage of the solid carbon dioxide blocks result in less than 50 percent loss. It was developed in this form by the Dehydration Committee. Unlike water ice, this product changes directly into a gas when heated. Solid carbon dioxide is shipped for use regularly from Berkeley, California, to inland points 120 miles away. It is packed in a quadruple corrugated carton to insulate the block, which maintains itself at a temperature of approximately minus 70° F. A 10-inch cube weighs 55 pounds. A top-opening bin should hold 3 cubic feet for every 10 tons of plant capacity. Losses per day are 10 percent during shipment and 6 percent per day in storage.

A storage bin should probably hold enough solid carbon dioxide for three days' operations. Let us consider a cabbage dehydrater with a daily capacity

of 10 tons [illegible]. By reference to Table [illegible], it is seen [illegible] an average of [illegible] cans will be the daily output, or 750 cans in [illegible] days. One-quarter [illegible] carbon dioxide is used per can, which amounts to 188 pounds net in [illegible] average storage time will be 2 days at [illegible] percent loss per [illegible] receipt of 112 percent of 188 pounds, i.e., of 210 pounds. [illegible] "dry ice", space for 50 pounds additional may be allowed [illegible] total to be stored at any time to [illegible] pounds. Since one [illegible] weighs 95 pounds, the bin should have a capacity of 3 cubic [illegible]

[illegible] wood for the framework of such storage bins, and metal or [illegible]. Use a 6-inch layer of cork slab insulation, if procurable, [illegible], or their equivalent in redwood fiber or other insulating material. [illegible] wood fiber or other flocculent material [illegible] used, tar paper is placed [illegible] outside of the insulation to prevent ice formation in the insulation. [illegible], use a light, 4-inch-thick kapok [illegible] covered with duck since [illegible] poised cover is frequently left open much of the time because of effort [illegible] raise and close it.

A [illegible] needed to break the solid carbon dioxide into a coarse [illegible] box to catch the "snow" and a [illegible] holding one-fourth pound of [illegible] material will be required. Gloves should be worn to prevent injury [illegible]

[illegible] have a 1/16-inch hole punched in [illegible] lid to permit [illegible] air. The hole is [illegible] located in [illegible] a drilled hole [illegible] of the untinned [illegible] of the hole.

In order [illegible] ice which will keep the bottoms freely exposed to water a shallow [illegible] wider than the cans is required. [illegible] bottom of this trough [illegible] with two strips about 1 inch high. Slowly flowing water [illegible] trough at a maintained depth of 4 to [illegible] inches. The trough [illegible] between the packing station and the capping machine. A second trough [illegible] without water, receives the capped cans. Its length should [illegible] will stand in it 10 to 15 minutes after being capped. A hand soldering station is located at the discharge end of the second trough.

Solid carbon dioxide is available throughout the country. There are two or more large chains of distributors. One chain has seven plants or warehouses on the West Coast alone.

[illegible] Dioxide "Snow" Method

The method [illegible] effective. A little carbon dioxide "snow" is prepared by grinding and sifting through a sieve having ten meshes per linear inch. One-fourth pound is scooped up in a measure and poured into an empty, tared 5-gallon can on the scales. The accuracy of the scooped weight is checked so that the correct net weight of vegetables will be assured. The ground material is shaken quite evenly over the bottom of the can. The operator then weighs in the cabbage or carrots and sets the lid loosely but accurately on the opening and the can is placed in the water trough.

[illegible] carbon di[illegible] [illegible] the gas [illegible] now [illegible] the v[illegible] heavier [illegible] pushes the air [illegible] until [illegible] occurred. [illegible] of the process [illegible] will not [illegible]

[illegible] however, [illegible] will have [illegible]. While [illegible] content [illegible] pressure [illegible]

[illegible] in the No. [illegible] Without [illegible] short [illegible] No. 1.

The [illegible] frost-nipped [illegible] too [illegible] from the method [illegible] should [illegible] carbon dioxide, [illegible] 10-mesh, [illegible] provided in the [illegible] experim[illegible] cabbage [illegible] [illegible] to 1 percent [illegible] [illegible]-eighth [illegible] produce[illegible] 1 percent oxygen [illegible] used in th[illegible]

Vacuum-Bell Method

The [illegible] removing air [illegible]-gallon cans [illegible] replacing it with [illegible] may be termed the vacuum-bell method. The method requ[illegible] similar to that of a vacuum canning operation. There is a flat pl[illegible] one or more cans. The [illegible] of the plate is machin[illegible] cans are placed on the [illegible] and are covered by a heav[illegible] with a counterpoise [illegible] evacuation of the air under [illegible] provided. The [illegible] of the equipment [illegible] of the joint [illegible] the bell [illegible] the plate, go[illegible] air inward, and on the degree of vacuum to which the pump [illegible] the air in the can [illegible]. Some pumps a[illegible] rotary. The latter [illegible], when properly [illegible] tightly fitting bell [illegible] quarter of an inch [illegible] of absolute vacuum. [illegible] pumps may be [illegible] of oxygen, however [illegible] cans. Many [illegible] staged, thus in[illegible] obta[illegible] oxygen content in the [illegible] the [illegible] space is so adjusted that [illegible] be removed [illegible] to cause it to [illegible] vacuum is [illegible] relieving the vacuum.

The vacuumizing and gassing procedures are carried on as follows: The can is filled with a weighed amount of dehydrated vegetables, and a cover placed on it. The cover is held above the can by indentations in the periphery. The resultant space between the can and cover allows a free flow of air out of the can and of inert gas into it. The filled can with cover is next placed under the vacuum bell and the bell is lowered. A vacuum of at least 29 inches is now drawn on the bell and this vacuum is immediately released with nitrogen or carbon dioxide. To be certain that the vacuum is relieved, a positive pressure of 1 to 2 pounds per square inch is built up in the bell. The bell is now opened and the can is removed and hermetically sealed immediately.

The Cylinder and Meter Method

The most common method of removing air has been by the use of gas run from a cylinder through a reducing valve, a rubber tube, and a metal purge tube thrust to the bottom of the can. The amount of gas is controlled by the pressure setting of the reducing valve and the duration of flow. The setting has usually been based on the time required to extinguish a flame at the mouth of the can. While this has sometimes resulted in analyses below 2 percent oxygen, the time is not accurately measured so that analyses of cans treated in this way have been found to vary several-fold in oxygen content.

The Dehydration Committee has found that the introduction of an iron-case dry gas meter between the cylinder and purge tube was of great assistance. The stock meter used was equipped with one of the dials showing 1 cubic foot per revolution.

To purge a can, the gauge is set at 30 pounds per square inch, the purge tube is thrust to the bottom of the can, the lid is slid over the opening as far as possible, and 2 cubic feet of gas is allowed to pass. The tube is removed, the lid is set in place and the cap is clinched or seamed tight. When carbon dioxide is used, 1.5 to 1.8 percent oxygen will be attained in the closed can. With nitrogen, results may be over 2 percent.

Control of Insect Infestation

Paragraph C-1-b, Tentative Federal Specifications for Dehydrated Sweetpotatoes, June, 1942, reads as follows: "If there is evidence of insect infestation in the packaging room or the package, it shall be required that the product and the packages be heated to 135° F. immediately before packaging." Gas packing of carrots and cabbage is specified. This results in an additional safeguard against insect infestation, since it has been established that an oxygen content of less than 2 percent destroys insect life in all stages of development.

Labeling

Labeling is described by Army, Navy, or Lend-Lease contracts. Current tentative U. S. Army and Federal Specifications require, unless otherwise specified, that each container shall be marked with the following:

Name and type of product, the net weight in pounds, the month and year of

dehydration, name of packer, location of processing plant, and specific directions for rehydration.

Packing

Packing is defined in both Tentative U. S. Army and Federal Specifications 2/. Weatherproof solid fiber, and nailed or wire-bound wood boxes are the types specified for export shipments. The Agricultural Marketing Administration has used the same specifications in connection with Tentative Federal Specifications.

Marking the Shipping Container

Marking of shipping containers normally consists of:

Name and type of product, the net weight of the product, the gross weight of and volume occupied by the container, the date of packaging, and the name of the contractor.

It is important for the operator to stencil finished boxes daily. The stencil shows the date of packing. In case inspection or analysis of the product reveals too high a moisture content, for example, the number of cases of product subject to question will be less than would be the case if several days' product had been grouped together.

Storage at the Dehydrator

Cases of dehydrated vegetables should be stored under cover. They should be away from the roof, or separated from it by an air space to avoid heat from the roof.

Two 5-gallon cans occupy 1.75 cu. ft. when boxed or 87.5 cu. ft. per one hundred 5-gallon cans. A 50-ton plant operating on white potato strips would pack 10,000 to 14,000 5-gallon cans in 7 days. These cans, crated, will occupy 9,000 to 12,000 cu. ft. This is without an allowance for aisles.

Dehydrated vegetables should be protected from heat so far as possible. They are known to keep for long periods when cold, and to spoil rapidly if they are maintained hot.

Measurements have been made on moisture content in relation to storage life. Clearly, the moisture content must be reduced below the point where molds will germinate and grow. Experiments at 90° F. have demonstrated that the life of cabbage, determined by retention of vitamin C, is increased 5[illegible] percent for

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2/ See War Department QMC Form #304, Revised. This may be procured by request from Chicago Quartermaster Depot, 1819 West Pershing Road, Chicago; California Quartermaster Depot, 11th and Clay Streets, Oakland, California, or other Depots.

each 1 percent decrease in the moisture content. This relation held over the range of 12 to 3 percent moisture. Similar relations have been noted between moisture content and palatability of carrots.

When a processor turns out a product that is regularly 1 percent below specification limits for moisture, he may rest assured that by so doing he is lengthening the storage life of his product by a substantial amount.

For further detailed information address:

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